

(19) 日本国特許庁 (J P)

(12) 公開特許公報 (A)

(11) 特許出願公開番号

特開平7-46125

(43) 公開日 平成7年(1995)2月14日

(51) Int. Cl. ⁴	識別記号	序内整理番号	P I	技術表示箇所
H 0 8 L 7/18 7/000		9182-5J 9182-5J	H 0 8 L 7/18 7/00	Z E

審査請求 有 請求項の数 1 F D (全 7 頁)

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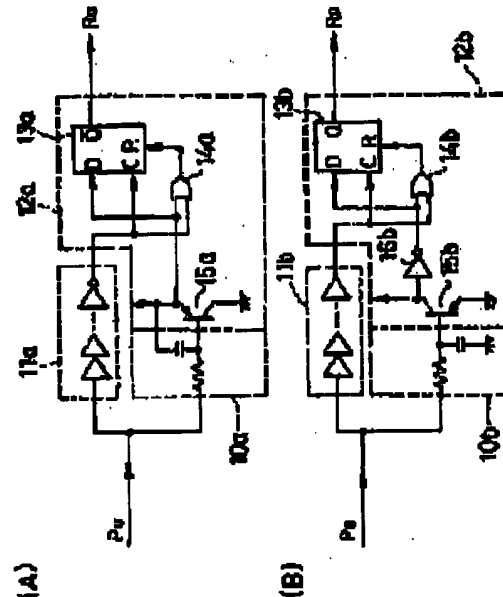
(54) 発明の名称 PLL回路

(57) 【要約】

【目的】 受信システムの周波数シンセサイザにおけるPLL回路のS/N改善のために位相比較にデッドゾーンを設けつつ安定な同期収束を可能とする。

【構成】 位相進みPDパルスを遅延部11bで遅延してD-FF13bのクロック入力とする。また、PDパルスを時定数回路10bで積分し、この積分波形をトランジスタ15bの閾値と比較してこの閾値以上のときにパルスを生成する。このパルスをD-FF13bのデータ入力としてPDパルスをラッチし、オアゲート14bでPDパルス消滅時にD-FF13bをリセットする。このQ出力Rdをチャージポンプ、ループフィルタへ供給してVCOの制御電圧を得る。

【効果】 デッドゾーンは時定数回路のCRとトランジスタの閾値で定まり、デッドゾーンより大なるPDパルスはそのまま出力されるので、同期収束が安定となる。



(2)

特開平7-48125

1

【特許請求の範囲】

【請求項1】 電圧制御回路手段と、この発振出力周波数信号と外部共振周波数信号との位相比較をなす位相比較手段と、この位相比較出力に応じて前記電圧制御回路手段の制御電圧を生成する制御電圧生成手段とを含むPLL回路であって、前記制御電圧生成手段は、前記位相比較出力を通過する遅延手段と、前記位相比較出力を入力とする遅延回路と、前記遅延手段の出力によって前記遅延回路の出力状態をラッチし前記遅延手段の出力が消失したときにこのラッチ状態を解除するラッチ手段とを

10

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明はPLL（フェイズロック・ループ）回路に関し、特に高精度化技術における安定な同期信号を得るために用いられるPLL回路に関する。

【0002】

【従来の技術】 PLL回路は、外部から与えられる基準周波数信号と、VCO（電圧制御発振器）の発振出力を分周した分周出力との位相差を検出し、その位相差に応じた直流電圧によりVCOを制御して安定な発振出力を得るものである。

【0003】 受信システムにおいて、この発振出力をローカル発振信号として受信RF信号と混合し、IF信号を作成するようになり、チャンネル切換え時の周波数切換えには、分周器（プログラムデバイダ）の分周比を変更するか、あるいは基準周波数信号自体を信号源にダイレクトデジタルシンセサイザ等を用いて変化させることにより同期を得ている。

【0004】 周波数同期周波数シンセサイザにおいては、高速の周波数切換えのためには、系の高利得設計が行われるが、その反面帯域幅特性が大きくなり、系内に雑音を取り込み易く、発振出力のC/N値が問題となる。こうした場合にネガティブな帰還として、位相比較における不感帯（デッドゾーン）を拡げる方法がとられる。

【0005】 図5は特開昭63-260317号公報に示された従来のPLL回路の位相比較部部分を示す回路図であり、21はチャージポンプ、22は第1のD-FF、23は第2のD-FF、24は第1のD-FF22のクロック入力端子に印加された基準周波数信号f_Rを遅延する第1の遅延回路、25は第2のD-FF23のクロック入力端子に印加された分周信号f_Pを遅延する第2の遅延回路である。26、24は遅延回路であり、28、29はデッドゾーン拡大信号DZに応じて遅延量を遅延する回路である。

【0006】 次に動作について説明する。D-FF22の入力端子D1には、D-FFの反転出力Q2が印加され、D-FF23の入力端子D2にはD-FF22の反転出力Q1が印加され、出力Q1はチャージポンプ回路

50

2

21のNMOS26のゲートに印加され、出力Q2はNMOS27のゲートに印加される。

【0007】 デッドゾーン拡大信号DZをオフ

（“0”）にすると、遅延回路の遅延量の遅延信号が選択回路28、29より選択される。

【0008】 まず、分周信号f_Pに対して基準周波数信号f_Rの位相が一致しているとき、図6（A）に示す様にf_Pとf_Rの立上りにより、D-FF22、23は共に互いの反転出力“1”を取込んで各々出力Q1及びQ2に出力する。この出力Q1及びQ2は、図6（C）の様に実線で示される傾斜で上昇し、スレッショルド電圧V_tに達する時点TDで選択回路28、29の出力R1とR2が立上る。

【0009】 すなわち、遅延回路24、25の最大遅延量はTDと等しくなる様に設計しており、出力R1、R2によりD-FF22、23は共にリセットされ、出力Q1及びQ2は低下し、従ってこの場合、NMOS26、27は共にオンせず、位相差に応じた出力PDは出力されない。

20

【0010】 図6（B）で示される如く、f_Rが10nsec早くなった状態では、D-FF22は“1”を取込み、出力Q1は（C）の点線の如くに立上る。D-FF23は10nsec遅れてf_Pの立上りで“1”を取込み、その出力Q2が上昇する。次に選択回路28からR1'が出力されると、D-FF23はリセットされ、出力Q2はV_tに達する前に、（C）の破線の如くに立下がる。

30

【0011】 一方、D-FF22の出力Q1はV_tに達し、選択回路29の出力R2によりD-FF22がリセットされることになる。従って、出力Q1がV_t以上になった瞬間、NMOS28がオンとなり、位相差に応じた出力PD“0”が出力される。すなわち、図6（C）の場合には、f_Rが早くなると、出力R2が出力される前に必ずV_tに達することになり、デッドゾーンは零となるのである。

【0012】 次に図6（D）はDZ＝“1”の場合であり、DZ＝“0”の時より、遅延量の多い遅延信号が選択される。まずf_Rとf_Pの位相が一致している時には、遅延回路の出力R1とR2が発生するのがTDより早くなるので、Q1とQ2はV_tに達せずにD-FF22、23がリセットされる。

【0013】 いま、出力R1とR2がTDより10nsec早い遅延信号であるとした時、f_Rが図6（D）の如く、10nsec早くなった場合、D-FF22の出力Q1は（D）の実線で示される如く上昇し、V_tに達する直前において、出力R2が発生するためにD-FF22がリセットされ、Q1は低下する。

【0014】 したがって、図6（E）の場合には、f_Rとf_Pの位相差が10nsec以内では、出力Q1がV_tに達する前に必ずD-FF22がリセットされること

(3)

特開平7-48125

になり、NMOS26がオンとなって位相差に対応する出力P0が発生されることはない。すなわち、10nsecのデッドゾーンが設けられる。同様にfPがfRより早くなった場合は、10nsec以下であれば、D-FF23の出力Q2がVtに達する前にD-FF23がリセットされるので、10nsecのデッドゾーンが発生する。

【0015】デッドゾーンを設けることにより、PLL回路がロックしている状態でVCOの外乱となるような制御パルスの無効な発生が防止され、またジッターノイズ等の雑音信号もカットされ、S/Nを大幅に改善している。

【0016】

【発明が解決しようとする課題】上述した従来の位相比較回路で構成したPLL回路においては、デッドゾーン近傍での位相差に対して、系の反応が鈍化する問題がある。

【0017】例えば、fRがfPに対して12nsec早くなった場合を想定すると、図7に示す様になる。DZ="0"のデッドゾーン0の状態では、出力Q1がVtを超えている時間は約12nsecとみることができ、P0信号として「1」が12nsec出力されるが、DZ="1"のデッドゾーン10nsecの状態では、出力Q1がVtを超える時間約2nsecとなり、P0信号として「1」は2nsec間しか続かず、ループフィルタを通してのVCOの制御を行う積分電圧値の直化の割合が鈍くなる。

【0018】この位相比較の特性を図1に示すと図8のようになる。fRとfPの位相差が大きい時には、相対的にみてそのデッドゾーン設定分の10nsecで割られる時間が小さくなるため、影響は少なくなるが、デッドゾーン近傍でかなり系としての感度は劣化する。

【0019】具体的には、PLL回路の発振周波数の切換時、シフト周波数付近への変化に支障はないが、収束値付近での同様に影響が出て、収束値に対して振動が尾を引く現象が生じ易い問題点がある。

【0020】本発明の目的は、位相比較時にデッドゾーンを設けつつ安定な同期収束を可能としたPLL回路を提供することである。

【0021】

【課題を解決しようとする手段】本発明によれば、電圧制御発振手段と、この発振出力周波数信号と外部発振周波数信号との位相比較をなす位相比較手段と、この位相比較出力に応じて前記電圧制御発振手段の制御電圧を生成する制御電圧生成手段とを含むPLL回路であって、前記制御電圧生成手段は、前記位相比較出力を遅延する遅延手段と、前記位相比較出力を入力とする時定数回路と、前記遅延手段の出力によって前記時定数回路の出力状態をラッチし前記遅延手段の出力が消失したときにこのラッチ状態を解除するラッチ手段とを含む、このラッ

チ出力を用いて前記制御電圧を生成するように構成されていることを特徴とするPLL回路が得られる。

【0022】

【実施例】以下に本発明の実施例について図面を参照しつつ詳細に説明する。

【0023】図1は本発明の実施例のブロック図であり、基準周波数fRを発生する発振器1の出力は位相比較器3の—入力となる。この位相比較器3の他入力には、VCO7の発振周波数を分周器2にて分周した周波数fPの信号が印加されている。

【0024】位相比較器3からは、位相差に応じたパルス幅の進み信号P0と遅れ信号PUが出力され、フィルタ回路4a、4bへ夫々入力される。このフィルタ回路4a、4bが本発明の特徴部分の回路であって図2にその一具体例が示されている。このフィルタ回路4a、4bにおいて、デッドゾーンが設定されつつP0、PUのパルス幅（位相差情報を含んでいる）が変化することのない、位相差信号RU、RDが生成される。

【0025】この位相差信号RU、RDはチャージポンプ5を介してループフィルタ6へ入力され積分されることによりVCO7の制御電圧となる。

【0026】このVCO7の出力が受信システムにおけるローカル発振周波数となっており、受信チャンネルの切換え指令に応じて基準周波数発振器1の発振周波数fR及びプログラムデバイダ2の分周比がコントロールされ、PLL周波数シンセサイザを構成している。

【0027】図2(A)、(B)は図1のフィルタ回路4a、4bの各具体例回路図である。まず、図2(A)を参照すると、進み信号PUは遅延回路11a及び時定数回路10aへ夫々入力される。遅延回路11aの遅延出力は、ラッチ回路12aを構成するD-FF13aのクロック入力となる。

【0028】時定数回路10aの出力は、ラッチ回路12aを構成するPNPトランジスタ15aのベース入力となり、このトランジスタ15aのエミッタ出力はD-FF13aのデータ入力となると共に、オアゲート14aの—入力となる。このオアゲート14aの他入力には遅延回路11aの遅延出力が印加され、オア出力はD-FF13aのリセット入力となっている。そして、D-FF13aの反転Q出力がRUとなる。

【0029】図2(B)は遅れ信号PU側についても、具体的に遅延回路11b、時定数回路10b及びラッチ回路12bからなっているが、時定数回路10bの電流ラインの極性、ラッチ回路内のトランジスタ15bの極性が進み信号PU側とは逆となっており、また、トランジスタ15bのコレクタ出力はインバータ16bにて極性反転されてD-FF13bのデータ入力及びオアゲート14bの—入力となっている。

【0030】図3は図2(B)の回路の動作を示す各信号波形図であり、fRがfPに対して位相が遅れたと

特開平7-46125

(4)

8. 遅れ信号PDが出力された場合のものであって、本例では遅れ度合が異なる2つのPDパルスを示している。

【0031】(C)に示すPDパルスは時定数回路10bの時定数によって(d)に示す立上りの緩やかな波形(積分波形)に変換される。この波形がトランジスタ15bの閾値Vtに達しないPDパルスでは、トランジスタ15bはオンせず、よってインバータ16bからD-FF13bへのデータ入力信号(D入力信号)は生成されない。一方、積分波形が閾値Vtに達するPDパルスでは、トランジスタ15bはオンしてインバータ16bからデータ入力信号が(e)に示す如く生成され、このデータ入力信号は積分波形が閾値Vtより小となるまで生成される。

【0032】D-FF13bのクロック入力にはPDパルスが時間1Dだけ遅延された(f)に示す如き遅延PDパルスが供給されている。ここで、遅延時間1Dと時定数回路10bの時定数により定まる時間1M(図(e)参照)とを略同か若しくは1Mを1Dより若干小に選定しておけば、クロック信号(遅延)パルスPDの立上りタイミングに同期しD-FF13bにはデータ入力信号が取込まれてラッチされる。

【0033】遅延PDパルスが立下がると、オアゲート14bの出力によりD-FF13bはリセットされるので、ラッチ状態がリセットされ、結果として(g)に示すフィルタ回路出力RDが得られることになる。

【0034】従って、位相差に応じた遅み信号PDは、その位相差の度合によってはフィルタ回路4b(図1)を通すことにより後段のチャージポンプ5へ入力されることなく、よってフィルタ回路12bの閾値Vtにより定まる時間1Mがデッドゾーンとなるのである。

【0035】デッドゾーンを越える位相遅み信号PDについては、そのパルスの波形が変化することなくチャージポンプ5へ出力されるので、デッドゾーン近傍において、VCO7の制御を行う積分電圧値の変化の割合が、従来の如く鈍くなることはない。位相比較特性としては図4に示すものが得られる。

【0036】尚、フィルタ回路4a、4bの出力RU、RDのPU、PDに対する遅延時間TDについては、デッドゾーン1Mを100ns(10MHz)またはそれ以上としても、ローカル発振周波数のチャンネル切換

時に要求される収束時間(1ms以下のオーダー)に比し無視できる。

【0037】図2の回路は一例に示すに止まるもので、種々の回路変形が可能であることは明らかである。

【0038】

【発明の効果】以上のべた様に、本発明によれば、PLL受信システムにおいて要求される高速チャンネル切換のために高利得でPLLを設計した場合にも、位相比較におけるデッドゾーンを設定しつつチャンネル切換時に収束値近傍での振動や引き込み現象を伴うことのない高性能PLL回路が実現できるという効果がある。

【0039】定量的に述べると、S/N値で10dB以上の改善があり、チャンネル切換収束時間で2ms以上の短縮が図れるものである。

【図面の簡単な説明】

【図1】本発明によるPLL回路のブロック図である。

【図2】図1のフィルタ回路4a、4bの一例を示す回路図である。

【図3】図2の回路の各部動作波形図である。

【図4】本発明によるPLL回路の位相比較特性図である。

【図5】従来のPLL回路の位相比較特性図である。

【図6】図5の回路の各部動作波形図である。

【図7】図5の回路の各部動作波形図である。

【図8】図5の回路の位相比較特性図である。

【符号の説明】

1 基準周波数発振器

2 分周器

3 位相比較器

4a、4b フィルタ回路

5 チャージポンプ

6 ループフィルタ

7 VCO

10a、10b 時定数回路

11a、11b 遅延回路

12a、12b ラッチ回路

13a、13b D-FF

14a、14b オアゲート

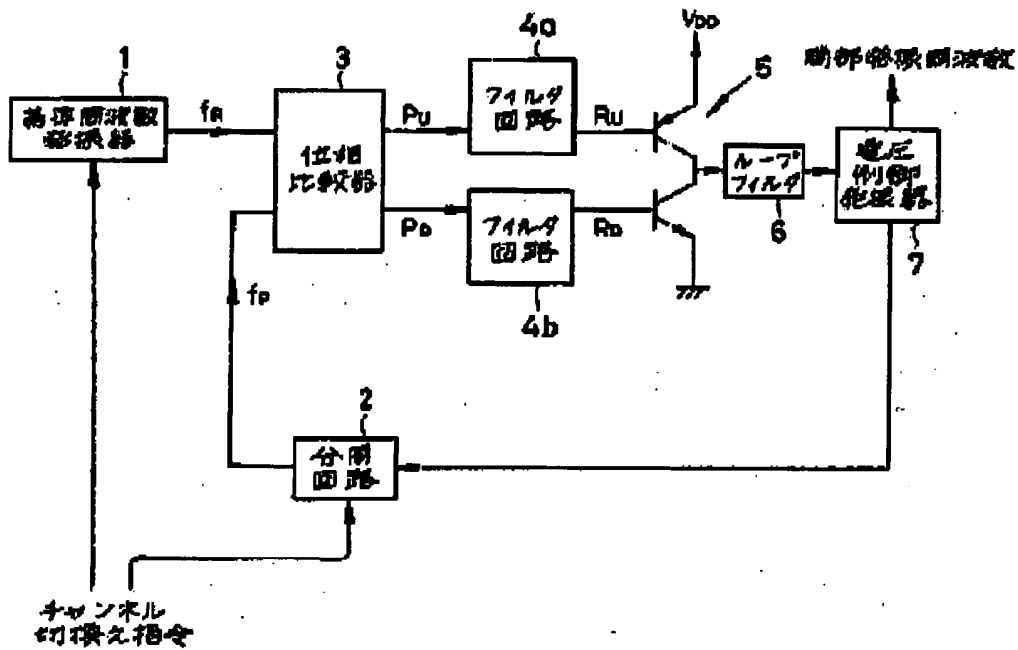
15a、15b トランジスタ

16b インバータ

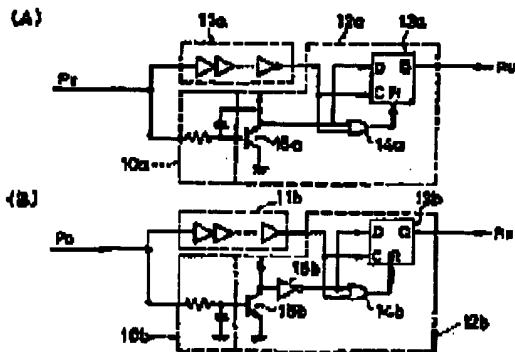
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特開平7-46125

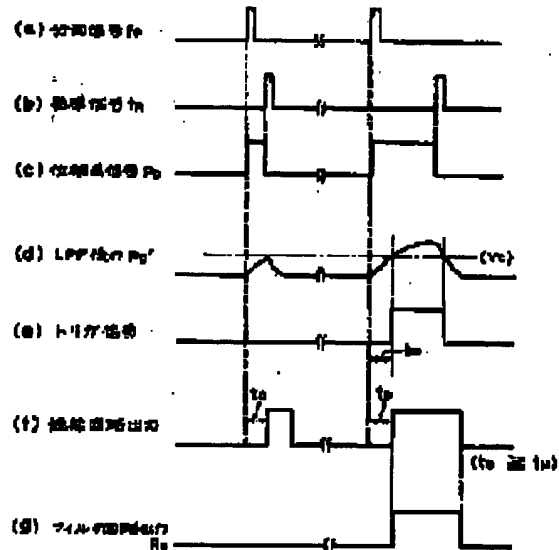
【図1】



【図2】



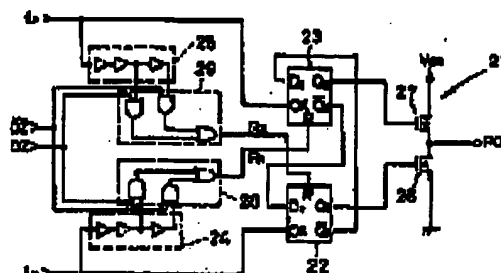
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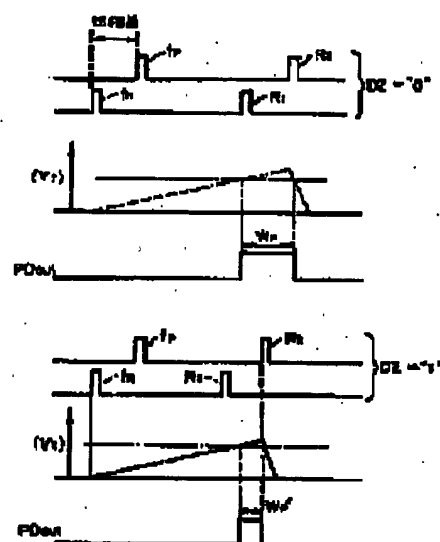
特開 2003-46125

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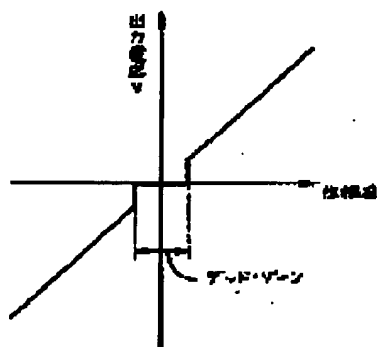
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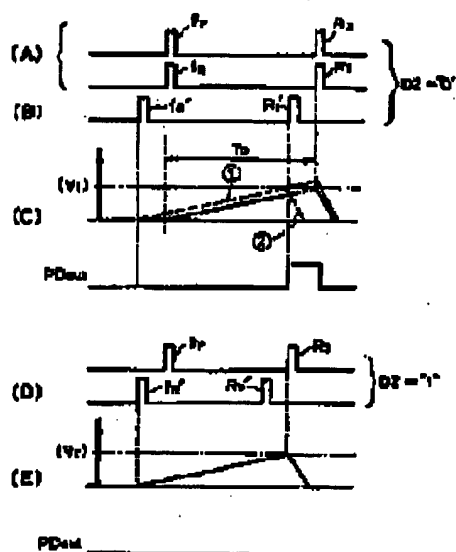
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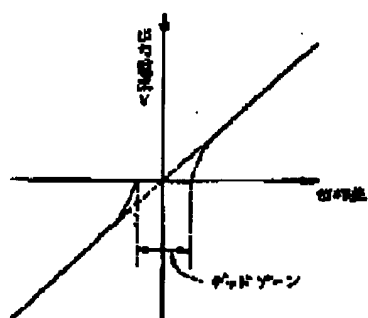
【図4】



【図6】



【図8】



(7)

特開平7-46125

【手続補正】

【補出日】平成8年1月10日

【手続補正1】

【補正対象書類名】明細書

【補正対象項目名】発明の名称

【補正方法】変更

【補正内容】

【発明の名称】 PLL回路

【手続補正2】

【補正対象書類名】明細書

【補正対象項目名】特許請求の範囲

【補正方法】追加

【補正内容】

【特許請求の範囲】

【請求項1】 電圧制御発振手段と、この発振出力周波数信号と外部参照周波数信号との位相比較をなす位相比較手段と、この位相比較出力に応じて前記電圧制御発振手段の制御電圧を生成する制御電圧生成手段とを含むPLL回路であって、前記制御電圧生成手段は、前記位相比較出力を遅延する遅延手段と、前記位相比較出力を入力とする時定数回路と、前記遅延手段の出力によって前記時定数回路の出力状態をラッチし前記遅延手段の出力が消失したときにこのラッチ状態を解除するラッチ手段とを含み、このラッチ出力を用いて前記制御電圧を生成するよう構成されていることを特徴とするPLL回路。

【請求項2】 前記位相比較手段は、前記発振出力周波数信号と外部参照周波数信号との一方に対する他方の位相ずれを検出して位相進み及び遅れに夫々対応した位相比較出力を生成するよう構成されており、前記遅延手段、前記時定数回路及びラッチ手段の各々は前記位相進み及び遅れに夫々対応した位相比較出力に夫々対応して設けられていることを特徴とする請求項1記載のPLL回路。

【請求項3】 前記遅延手段の遅延時間は、前記位相比較における不感帯（デッドゾーン）に相当する時間に設定されていることを特徴とする請求項1または2記載のPLL回路。

【手続補正3】

【補正対象書類名】明細書

【補正対象項目名】0008

【補正方法】変更

【補正内容】

【0008】次に動作について説明する。D-FF22の入力端子D1には、D-FF23反転出力Q2が印加され、D-FF23の入力端子D2にはD-FF22の反転出力Q1が印加され、出力Q1はチャージポンプ回路21のNMOS26のゲートに印加され、出力Q2はNMOS27のゲートに印加される。

【手続補正4】

【補正対象書類名】明細書

【補正対象項目名】0016

【補正方法】変更

【補正内容】

【0016】デッドゾーンを設けることにより、PLL回路がロックしている状態でVCOの外乱となるような制動パルスの頻発が防止され、またジッタノイズ等の雑音信号もカットされ、S/Nを大幅に改善している。

【手続補正5】

【補正対象書類名】明細書

【補正対象項目名】0017

【補正方法】変更

【補正内容】

【0017】例えば、 f_R が f_P に対して12nsec早くなった場合を想定すると、図7に示す様になる。DZ = "0"のデッドゾーン0の状態では、出力Q1がV_rを超えている時間は約12nsecとみることができ、PD信号として"1"が12nsec出力されるが、DZ = "1"のデッドゾーン10nsecの状態では、出力Q1がV_rを超える時間は約2nsecとなり、PD信号として"1"は2nsec間しか続かず、ループフィルタを通してのVCOの制御を行う偏分電圧値の変化の割合が稀くなる。

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 08-288843
 (43)Date of publication of application : 01.11.1996

(51)Int.Cl.

H03L 7/18
 H03L 7/093
 H03L 7/089

(21)Application number : 07-083999

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(22)Date of filing : 10.04.1995

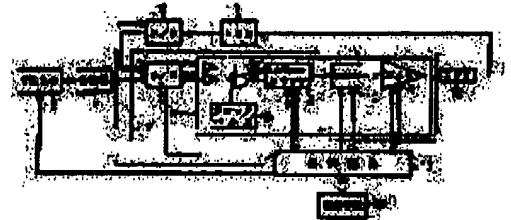
(72)Inventor : WASHIMI IKUAKI

(54) PLL SYNTHESIZER

(57)Abstract:

PURPOSE: To provide the PLL synthesizer consisting of parts where charge pump control and storage are easy.

CONSTITUTION: A charge pump 8 consists of an up/down counter 9 which counts the phase difference between an up signal Pu and a down signal Pd of a phase comparator 5, a latch 10 where the output value of the up/down counter 9 is held, and a digital-analog converter 11 which converts the output of the latch 10 into an analog signal. Thus, power saving and temperature correction are facilitated, and the strength against noise is improved. For the purpose of shortening the lock-up time, it is unnecessary to prepare and switch two charge pumps or to prepare and switch two resistances.



LEGAL STATUS

[Date of request for examination] 30.07.2001
 [Date of sending the examiner's decision of rejection] 06.05.2003
 [Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
 [Date of final disposal for application]
 [Patent number]
 [Date of registration]
 [Number of appeal against examiner's decision of rejection]
 [Date of requesting appeal against examiner's decision of rejection]
 [Date of extinction of right]

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CLAIMS

[Claim(s)]

[Claim 1] A voltage controlled oscillator and the programmable divider which carries out dividing of the output of this voltage controlled oscillator in adjustable, The phase comparator which outputs the rise signal Pu which detects the phase contrast of the output from reference frequency VCO and this frequency VCO, and the output of a programmable divider, and shows this phase contrast by pulse width, and the down signal Pd, In the PLL synthesizer which consisted of low-pass filters which change into the control voltage to a voltage controlled oscillator the voltage of the charge pump which changes the rise signal Pu from this phase comparator, and the down signal Pd into voltage, and this charge pump The counter the aforementioned charge pump counts [counter] the phase contrast of the aforementioned rise signal Pu and the down signal Pd, The PLL synthesizer characterized by consisting of a latch holding the output value of this counter, and a digital analog converter which changes the output of this latch into an analog signal.

[Claim 2] The PLL synthesizer indicated to the claim 1 characterized by having the control circuit which controls change of the aforementioned control voltage based on a storage means to memorize the data concerning the output of the aforementioned counter, and this storage means.

[Claim 3] The PLL synthesizer indicated to the claim 1 characterized by having the control circuit which has by the output value of the aforementioned counter corresponding to the division ratio changed based on the aforementioned storage means, and controls the aforementioned latch when there are a storage means to memorize the correlation of the output value of the aforementioned counter and the division ratio of a programmable divider, and change of a division ratio.

[Claim 4] It is the PLL synthesizer indicated to the claim 1 characterized by having a control circuit and a storage means, outputting the output of the latch which the aforementioned control circuit made the aforementioned storage means memorize the output of a latch, and was memorized by the aforementioned storage means to a digital analog converter, and intercepting at least one between a voltage controlled oscillator and a digital analog converter.

[Claim 5] It is the PLL synthesizer indicate holding the output-control voltage of the aforementioned low-pass filter in front of power-saving operation to the claim 1 carry out as the feature by making the aforementioned programmable divider into non-actuation by having the control circuit to which power-saving operation is made to perform, and a storage means, and the aforementioned control circuit's making the aforementioned storage means memorize the output of the aforementioned counter in front of power-saving operation, and controlling the aforementioned latch based on the aforementioned storage means at the time of power-saving operation.

[Claim 6] The PLL synthesizer indicated to the claim 1 characterized by having the control circuit which has by the output value of the aforementioned counter in a predetermined division ratio based on a storage means to memorize the correlation of the temperature of the reference frequency VCO in which temperature compensation is possible, and the output value of the aforementioned counter in a predetermined division ratio and reference frequency VCO, and the aforementioned storage means, and carries out temperature compensation of the reference frequency VCO.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the PLL synthesizer which has a charge pump.

[0002]

[Description of the Prior Art] Many PLL synthesizers to radio, portable telephone, etc. are used. There is a charge pump which changes the phase contrast signal from a phase comparator into the voltage to a low-pass filter in this PLL synthesizer. This charge pump consists of two FET (Field Effect Transistor) so that it may be indicated by JP, 58-22343, Y. Operation of a charge pump is explained. Drawing 5 is a block diagram of a PLL synthesizer which has a charge pump (15) as shown in drawing 6, and drawing 7 is a timing chart which shows operation of a phase comparator (ϕ/D) (5) and a charge pump (15). fp of these drawings is the output from a voltage controlled oscillator by which dividing was carried out by the programmable divider, and fr is the output from reference frequency VCO by which dividing was carried out with the counting-down circuit. If fp and fr are inputted into a phase comparator, only while the phase of fp is progressing rather than fr , the rise signal Pu of a phase comparator serves as Low, and while the phase of fp is behind fr , the down signal Pd of a phase comparator serves as Low. If each of $fp(s)$ and $fr(s)$ is High(s), each FET of both of a charge pump is in an OFF state, and the capacitor of a low-pass filter (12) holds fixed potential, and holds a lock. However, when Pu is set to Low, the capacitor of a low-pass filter (12) is made to charge, and when Pd is set to Low, the capacitor of a low-pass filter is made to discharge. In this way, the always stabilized oscillation frequency can be obtained from a voltage controlled oscillator.

[0003]

[Problem(s) to be Solved by the Invention] Since the conventional charge pump consisted of FET of the above analogs, it was not easy to control by the control circuit or to memorize the value of a charge pump. For this reason, based on the value of a charge pump, control of PLL operation, such as power saving and temperature compensation, was difficult. Moreover, since control of a charge pump was difficult, the conventional PLL control had the problem of taking lock-up time for a long time, when a change of a division ratio was made greatly, in order to start feedback control from the state at that time, when a change of a division ratio is made.

[0004] Furthermore, since the charge pump of the conventional example had amended the control voltage of a low-pass filter by charge and electric discharge like ****, the time constant of a low-pass filter (12) needed to be changed to shortening lock-up time. For this reason, as shown in drawing 8, a charge pump (15) and two (16) were prepared, this needed to be changed by the CONT signal, and two resistance needed to be prepared and this needed to be changed with a switch (17).

[0005]

[Means for Solving the Problem] this invention was made in view of this point, and the 1st feature is that a charge pump consists of a counter which counts the phase contrast of the aforementioned rise signal Pu and the down signal Pd , a latch holding the output value of this counter, and a digital analog converter which changes the output of this latch into an analog signal.

[0006] The 2nd feature is having had the control circuit which controls change of the aforementioned control voltage based on a storage means memorizing the data concerning the output of the aforementioned counter, and this storage means.

[0007] The 3rd feature is having the control circuit which has by the output value of the aforementioned counter corresponding to the division ratio changed based on the aforementioned storage means, and controls the aforementioned latch, when a storage means to memorize the correlation of the output value of the aforementioned counter and the division ratio of a programmable divider, and change of a division ratio are.

[0008] It is the 4th feature's being equipped with a storage means, outputting the output of the latch which the aforementioned control circuit's made the aforementioned storage means memorize the output of a latch, and was memorized by the aforementioned storage means to a digital analog converter, and intercepting at least one between a voltage controlled oscillator and a digital analog converter.

[0009] It is holding the output-control voltage of the aforementioned equipping the 5th feature with the control circuit to which power-saving operation is made to perform by making a programmable divider into non-actuation, and a storage means, and the aforementioned control circuit's making the aforementioned storage means memorize the output of the aforementioned counter in front of power-saving operation, and controlling the aforementioned latch based on the aforementioned storage means at the time of power-saving operation.

[0010] The 6th feature is having the control circuit which has by the output value of the aforementioned counter in a predetermined division ratio based on a storage means memorizing the correlation of the temperature of the reference frequency VCO in which temperature compensation's is possible, and the output value of the aforementioned counter in a predetermined division ratio and reference frequency VCO, and the aforementioned storage means, and carries out temperature compensation of the reference frequency VCO.

[0011]

[Function] Storage of control or an output is easy and can constitute a charge pump. Thereby, temperature compensation of power saving which makes a programmable divider non-actuation, shortening of lock-up time, and the reference frequency VCO is carried out.

[0012]

[Example] The example of this invention is explained based on drawing. Drawing 1 is the block diagram of a PLL synthesizer. (1) is a voltage controlled oscillator (VCO) and it outputs desired frequency outside. (2) is a programmable divider (P/D) and it carries out dividing of the output of a voltage controlled oscillator (1) in adjustable. (3) is a temperature compensated crystal oscillator (TCXO), and it can tune oscillation frequency finely. (4) is a counting-down circuit and it carries out dividing of the output of a temperature compensated crystal oscillator (3). (5) is a phase comparator (ϕ/D) and it outputs the phase contrast of the output f_r of a temperature compensated crystal oscillator (3) by which dividing was carried out to the output f_p of a voltage controlled oscillator (1) by which dividing was carried out, and detection of a lock. Phase contrast is outputted by the rise signal P_u and the down signal P_d . (6) is a charge pump and it changes the rise signal P_u from a phase comparator (5), and the down signal P_d into voltage. A charge pump (6) is aligned with a phase comparator (5), and it is called the phase comparator (7) of a wide sense. On the other hand, (5) which does not contain a charge pump (6) is a phase comparator in a narrow sense. Here, a phase comparator in a narrow sense is only called phase comparator.

[0013] A charge pump (6) consists of a clock pulse (8), an updown counter (Up/Down counter) (9), and a latch (Latch) (10) and a digital analog converter (11) (DAC). An updown counter (9) counts each phase contrast from the rise signal P_u from a phase comparator (5), and the down signal P_d . A clock pulse (8) sends out the reference pulse signal for the count of an updown counter (9). A latch (10) holds the output of an updown counter (9). That is, the output of an updown counter (9) is temporarily memorizable. A digital analog converter (11) changes into the voltage according to counted value the output of the latch (10) which is a digital signal. (12) is a low-pass filter (LPF) and amends the control voltage to a voltage controlled oscillator (1) based on the output voltage of a digital analog converter (11).

[0014] (13) is a control circuit and controls each part. (14) is storage meanses, such as RAM and ROM, and memorizes data required for operation of a control circuit (13). For example, the correlation of the division ratio to the output of an updown counter (9) or temperature is memorized.

[0015] 12 is a timing chart which shows operation of a phase comparator (5) and an updown counter (9). If the output f_p of a programmable divider (2) and the output f_r of a counting-down circuit (4) are inputted into a phase comparator (5), only while the phase of f_p is progressing rather than f_r , the rise signal P_u of a phase comparator (5) serves as Low, and while the phase of f_p is behind f_r , the down signal P_d of a phase comparator (5) serves as Low. The pulse width of Low of P_u and P_d shows the phase contrast of f_p and f_r . This pulse width is changed into the signal (P_u' and P_d') expressed with the pulse width of High by the clock pulse (8) and the logical element (an inverter and AND gate). An updown counter (9) counts the pulse number of this P_u' and P_d' , and outputs the value as a DESHITARU signal. The digital-output signal of an updown counter (9) is held by latch (10), and is changed into the voltage (analog) according to counted value (phase contrast) by the digital analog converter (11). The control voltage of a low-pass filter (12) is amended on this voltage.

[0016] Thus, if the phase of f_p is progressing rather than f_r , while the control voltage of a low-pass filter (12) was raised and the phase of f_p is behind f_r , the control voltage of a low-pass filter (12) is dropped. In this way, the always stabilized oscillation frequency can be obtained from a voltage controlled oscillator.

[0017] The above is the basic composition and basic operation of this invention, and has the following features.

[0018] ** Since the charge pump of the conventional example had amended the control voltage of a low-pass filter (12) by charge and electric discharge, it needed to change the time constant of a low-pass filter (12) to shortening lock-up time. For this reason, as shown in drawing 8, two charge pumps were formed, this needed to be changed, and two resistance needed to be prepared and this needed to be changed. However, since the charge pump of this invention generates direct voltage, and in order for the speedup / speed down of applied voltage to a voltage controlled oscillator (1) to be dependent on the speed of a clock pulse (8), it is not necessary to take into consideration the time constant of a low-pass filter (12), and it has

neither a charge pump nor resistance doubly like before, or operation

[0019] * Since the processing inside a charge pump (6) is a digital signal, the digital control which used a microcomputer, RAM, the logical element, etc. is easy.

[0020] ** When a change of a division ratio is made, in order to start feedback control from the state at that time, the conventional PLL control takes lock-up time for a long time, when a change of a division ratio is made greatly. The control circuit (13) of this invention reads the correlation of a division ratio and the output value of an updown counter (9) from a storage means (14), when a setting change of a division ratio is made in a key stroke etc. (Y of S1), as shown in drawing 3 (S2). The tabular format of the updown counter (9) output value corresponding to the division ratio of it that is sufficient as a correlation, and the function by statistics, such as the least square method, is sufficient as it. By this correlation, the change value of the updown counter (9) corresponding to the change value of a division ratio is calculated, and this value is outputted to an updown counter (9) (S3). Feedback operation of PLL is performed by making this value into initial value (S4).

[0021] Furthermore, it has with the lock-up signal from a phase comparator (5) by the output value of (Y of S5), and the updown counter at this time (9), and the data of the aforementioned correlation of a storage means (14) are updated (S6). (study)

[0022] Unless it carried out operation by the loop conventionally, the convergence value of attenuation was not found. However, since an updown counter (9) and a latch (10) are digital signals, this invention can output the voltage assumed easily from a charge pump (6). For this reason, lock-up time can be shortened and especially the effect when a change of a division ratio is made greatly is greatest.

[0023] ** Since an output is digital, a clock pulse (8) and a latch (10) are easy for a control circuit (13) to input into the next circuit the output value which made the storage means (14) memorize this output value, and made it memorize. And even if it intercepts between a voltage controlled oscillator (1) and a charge pump (6), the control voltage of a low-pass filter (12) can be held.

[0024] For example, as shown in drawing 4, if the lock signal from a phase comparator (5) is received (S7), a control circuit (13) will make a storage means (14) memorize the output value of a latch (10) (S8), will read this output value from a storage means (14), and will output it to a digital analog converter (11) (S9). And between a latch (10) and digital analog converters (11) is intercepted (S10), and between a phase comparator (5) and charge pumps (6) is intercepted (S11). Next, supply (not shown) of the power supply to a programmable divider (2) is intercepted, and this is made into non-actuation (S12).

[0025] Thus, although a loop is intercepted and a programmable divider (2) serves as non-actuation, the control voltage of a low-pass filter (12) can be held by the output value of the latch (10) memorized. And by intercepting a loop, even if the noise by change of a phase comparator (5) is lost and a noise arises, a noise cannot carry out a loop and a PLL synthesizer strong against a noise can be supplied. Furthermore, power consumption can be lessened by making a programmable divider (2) into non-actuation.

[0026] an above-mentioned example -- especially -- power consumption -- although the large programmable divider (2) was made into non-actuation, even if it makes a counting-down circuit (4), a phase comparator (5), and an updown counter (9) into non-actuation, the output-control voltage of a low-pass filter can be held

[0027] Moreover, although DAC (11) was controlled by the above-mentioned example based on the output value of a latch (10), based on the output value of an updown counter (9), you may control a latch (10) (9).

[0028] ** Carry out small change of the frequency outputted from reference frequency VCO with temperature. For this reason, the control circuit (13) makes the storage means (14) memorize the correlation of the output value of an updown counter, and the temperature of reference frequency VCO in a predetermined division ratio beforehand. And temperature compensation of the reference frequency VCO is carried out to the division ratio set up from the output value of an updown counter using the correlation read from the storage means (14). Thereby, a temperature control with a high precision becomes possible.

[0029]

[Effect of the Invention] Since the processing inside a charge pump (6) is a digital signal, the digital control which used a microcomputer, RAM, the logical element, etc. is easy. This storage and control can perform power saving and temperature compensation. Moreover, a PLL synthesizer strong against a noise can be supplied.

[0030] Furthermore, in order to shorten lock-up time, two charge pumps are formed and the cure which changes this, or prepares two resistance and changes this is not needed.

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TECHNICAL FIELD

[Industrial Application] this invention relates to the PLL synthesizer which has a charge pump.

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PRIOR ART

[Description of the Prior Art] Many PLL synthesizers to radio, portable telephone, etc. are used. There is a charge pump which changes the phase contrast signal from a phase comparator into the voltage to a low-pass filter in this PLL synthesizer. This charge pump consists of two FET (Field Effect Transistor) so that it may be indicated by JP,58-22343, Y. Operation of a charge pump is explained. Drawing 5 is a block diagram of a PLL synthesizer which has a charge pump (15) as shown in drawing 6, and drawing 7 is a timing chart which shows operation of a phase comparator (ϕ/D) (5) and a charge pump (15). f_p of these drawings is the output from a voltage controlled oscillator by which dividing was carried out by the programmable divider, and f_r is the output from reference frequency VCO by which dividing was carried out with the counting-down circuit. If f_p and f_r are inputted into a phase comparator, only while the phase of f_p is progressing rather than f_r , the rise signal P_u of a phase comparator serves as Low, and while the phase of f_p is behind f_r , the down signal P_d of a phase comparator serves as Low. If each of $f_p(s)$ and $f_r(s)$ is High(s), each FET of both of a charge pump is in an OFF state, and the capacitor of a low-pass filter (12) holds fixed potential, and holds a lock. However, when P_u is set to Low, the capacitor of a low-pass filter (12) is made to charge, and when P_d is set to Low, the capacitor of a low-pass filter is made to discharge. In this way, the always stabilized oscillation frequency can be obtained from a voltage controlled oscillator.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since the processing inside a charge pump (6) is a digital signal, the digital control which used a microcomputer, RAM, the logical element, etc. is easy. This storage and control can perform power saving and temperature compensation. Moreover, a PLL synthesizer strong against a noise can be supplied.

[0030] Furthermore, in order to shorten lock-up time, two charge pumps are formed and the cure which changes this, or prepares two resistance and changes this is not needed.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Since the conventional charge pump consisted of FET of the above analogs, it was not easy to control by the control circuit or to memorize the value of a charge pump. For this reason, based on the value of a charge pump, control of PLL operation, such as power saving and temperature compensation, was difficult. Moreover, since control of a charge pump was difficult, the conventional PLL control had the problem of taking lock-up time for a long time, when a change of a division ratio was made greatly, in order to start feedback control from the state at that time, when a change of a division ratio is made.

[0004] Furthermore, since the charge pump of the conventional example had amended the control voltage of a low-pass filter by charge and electric discharge like ****, the time constant of a low-pass filter (12) needed to be changed to shortening lock-up time. For this reason, as shown in drawing 8 , a charge pump (15) and two (16) were prepared, this needed to be changed by the CONT signal, and two resistance needed to be prepared and this needed to be changed with a switch (17).

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MEANS

[Means for Solving the Problem] this invention was made in view of this point, and the 1st feature is that a charge pump consists of a counter which counts the phase contrast of the aforementioned rise signal Pu and the down signal Pd, a latch holding the output value of this counter, and a digital analog converter which changes the output of this latch into an analog signal.

[0006] The 2nd feature is having had the control circuit which controls change of the aforementioned control voltage based on a storage means memorizing the data concerning the output of the aforementioned counter, and this storage means.

[0007] The 3rd feature is having the control circuit which has by the output value of the aforementioned counter corresponding to the division ratio changed based on the aforementioned storage means, and controls the aforementioned latch, when a storage means to memorize the correlation of the output value of the aforementioned counter and the division ratio of a programmable divider, and change of a division ratio are.

[0008] It is the 4th feature's being equipped with a storage means, outputting the output of the latch which the aforementioned control circuit's made the aforementioned storage means memorize the output of a latch, and was memorized by the aforementioned storage means to a digital analog converter, and intercepting at least one between a voltage controlled oscillator and a digital analog converter.

[0009] It is holding the output-control voltage of the aforementioned low-pass filter in front of power-saving operation by equipping the 5th feature with the control circuit to which power-saving operation is made to perform by making a programmable divider into non-actuation, and a storage means, and the aforementioned control circuit's making the aforementioned storage means memorize the output of the aforementioned counter in front of power-saving operation, and controlling the aforementioned latch based on the aforementioned storage means at the time of power-saving operation.

[0010] The 6th feature is having the control circuit which has by the output value of the aforementioned counter in a predetermined division ratio based on a storage means memorizing the correlation of the temperature of the reference frequency VCO in which temperature compensation's is possible, and the output value of the aforementioned counter in a predetermined division ratio and reference frequency VCO, and the aforementioned storage means, and carries out temperature compensation of the reference frequency VCO.

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OPERATION

[Function] Storage of control or an output is easy and can constitute a charge pump. Thereby, temperature compensation of power saving which makes a programmable divider non-actuation, shortening of lock-up time, and the reference frequency VCO is carried out.

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EXAMPLE

[Example] The example of this invention is explained based on drawing. Drawing 1 is the block diagram of a PLL synthesizer. (1) is a voltage controlled oscillator (VCO) and it outputs desired frequency outside. (2) is a programmable divider (P/D) and it carries out dividing of the output of a voltage controlled oscillator (1) in adjustable. (3) is a temperature compensated crystal oscillator (TCXO), and it can tune oscillation frequency finely. (4) is a counting-down circuit and it carries out dividing of the output of a temperature compensated crystal oscillator (3). (5) is a phase comparator (ϕ/D) and it outputs the phase contrast of the output fr of a temperature compensated crystal oscillator (3) by which dividing was carried out to the output fp of a voltage controlled oscillator (1) by which dividing was carried out, and detection of a lock. Phase contrast is outputted by the rise signal Pu and the down signal Pd. (6) is a charge pump and it changes the rise signal Pu from a phase comparator (5), and the down signal Pd into voltage. A charge pump (6) is aligned with a phase comparator (5), and it is called the phase comparator (7) of a wide sense. On the other hand, (5) which does not contain a charge pump (6) is a phase comparator in a narrow sense. Here, a phase comparator in a narrow sense is only called phase comparator.

[0013] A charge pump (6) consists of a clock pulse (8), an updown counter (Up/Down counter) (9), and a latch (Latch) (10) and a digital analog converter (11) (DAC). An updown counter (9) counts each phase contrast from the rise signal Pu from a phase comparator (5), and the down signal Pd. A clock pulse (8) sends out the reference pulse signal for the count of an updown counter (9). A latch (10) holds the output of an updown counter (9). That is, the output of an updown counter (9) is temporarily memorizable. A digital analog converter (11) changes into the voltage according to counted value the output of the latch (10) which is a digital signal. (12) is a low-pass filter (LPF) and amends the control voltage to a voltage controlled oscillator (1) based on the output voltage of a digital analog converter (11).

[0014] (13) is a control circuit and controls each part. (14) is storage means, such as RAM and ROM, and memorizes data required for operation of a control circuit (13). For example, the correlation of the division ratio to the output of an updown counter (9) or temperature is memorized.

[0015] 12 is a timing chart which shows operation of a phase comparator (5) and an updown counter (9). If the output fp of a programmable divider (2) and the output fr of a counting-down circuit (4) are inputted into a phase comparator (5), only while the phase of fp is progressing rather than fr, the rise signal Pu of a phase comparator (5) serves as Low, and while the phase of fp is behind fr, the down signal Pd of a phase comparator (5) serves as Low. The pulse width of Low of Pu and Pd shows the phase contrast of fp and fr. This pulse width is changed into the signal (Pu' and Pd') expressed with the pulse width of High by the clock pulse (8) and the logical element (an inverter and AND gate). An updown counter (9) counts the pulse number of this Pu' and Pd', and outputs the value as a DESHITARU signal. The digital-output signal of an updown counter (9) is held by latch (10), and is changed into the voltage (analog) according to counted value (phase contrast) by the digital analog converter (11). The control voltage of a low-pass filter (12) is amended on this voltage.

[0016] Thus, if the phase of fp is progressing rather than fr, while the control voltage of a low-pass filter (12) was raised and the phase of fp is behind fr, the control voltage of a low-pass filter (12) is dropped. In this way, the always stabilized oscillation frequency can be obtained from a voltage controlled oscillator.

[0017] The above is the basic composition and basic operation of this invention, and has the following features.

[0018] ** Since the charge pump of the conventional example had amended the control voltage of a low-pass filter (12) by charge and electric discharge, it needed to change the time constant of a low-pass filter (12) to shortening lock-up time. For this reason, as shown in drawing 8, two charge pumps were formed, this needed to be changed, and two resistance needed to be prepared and this needed to be changed. However, since the charge pump of this invention generates direct voltage, and in order for the speedup / speed down of applied voltage to a voltage controlled oscillator (1) to be dependent on the speed of a clock pulse (8), it is not necessary to take into consideration the time constant of a low-pass filter (12), and it has neither a charge pump nor resistance doubly like before, or operation which changes this is not needed.

[0019] * Since the processing inside a charge pump (6) is a digital signal, the digital control which used a microcomputer, RAM, the logical element, etc. is easy.

[0020] ** When a change of a division ratio is made, in order to start conventional PLL control takes lock-up time for a long time, when a change of a division ratio is made greatly. The control circuit (13) of this invention reads the correlation of a division ratio and the output value of an updown counter (9) from a storage means (14), when a setting change of a division ratio is made in a key stroke etc. (Y of S1), as shown in drawing 3 (S2). The tabular format of the updown counter (9) output value corresponding to the division ratio of it that is sufficient as a correlation, and the function by statistics, such as the least square method, is sufficient as it. By this correlation, the change value of the updown counter (9) corresponding to the change value of a division ratio is calculated, and this value is outputted to an updown counter (9) (S3). Feedback operation of PLL is performed by making this value into initial value (S4).

[0021] Furthermore, it has with the lock-up signal from a phase comparator (5) by the output value of (Y of S5), and the updown counter at this time (9), and the data of the aforementioned correlation of a storage means (14) are updated (S6). (study)

[0022] Unless it carried out operation by the loop conventionally, the convergence value of attenuation was not found. However, since an updown counter (9) and a latch (10) are digital signals, this invention can output the voltage assumed easily from a charge pump (6). For this reason, lock-up time can be shortened and especially the effect when a change of a division ratio is made greatly is greatest.

[0023] ** Since an output is digital, a clock pulse (8) and a latch (10) are easy for a control circuit (13) to input into the next circuit the output value which made the storage means (14) memorize this output value, and made it memorize. And even if it intercepts between a voltage controlled oscillator (1) and a charge pump (6), the control voltage of a low-pass filter (12) can be held.

[0024] For example, as shown in drawing 4, if the lock signal from a phase comparator (5) is received (S7), a control circuit (13) will make a storage means (14) memorize the output value of a latch (10) (S8), will read this output value from a storage means (14), and will output it to a digital analog converter (11) (S9). And between a latch (10) and digital analog converters (11) is intercepted (S10), and between a phase comparator (5) and charge pumps (6) is intercepted (S11). Next, supply (not shown) of the power supply to a programmable divider (2) is intercepted, and this is made into non-actuation (S12).

[0025] Thus, although a loop is intercepted and a programmable divider (2) serves as non-actuation, the control voltage of a low-pass filter (12) can be held by the output value of the latch (10) memorized. And by intercepting a loop, even if the noise by change of a phase comparator (5) is lost and a noise arises, a noise cannot carry out a loop and a PLL synthesizer strong against a noise can be supplied. Furthermore, power consumption can be lessened by making a programmable divider (2) into non-actuation.

[0026] an above-mentioned example -- especially -- power consumption -- although the large programmable divider (2) was made into non-actuation, even if it makes a counting-down circuit (4), a phase comparator (5), and an updown counter (9) into non-actuation, the output-control voltage of a low-pass filter can be held

[0027] Moreover, although DAC (11) was controlled by the above-mentioned example based on the output value of a latch (10), based on the output value of an updown counter (9), you may control a latch (10) (9).

[0028] ** Carry out small change of the frequency outputted from reference frequency VCO with temperature. For this reason, the control circuit (13) makes the storage means (14) memorize the correlation of the output value of an updown counter, and the temperature of reference frequency VCO in a predetermined division ratio beforehand. And temperature compensation of the reference frequency VCO is carried out to the division ratio set up from the output value of an updown counter using the correlation read from the storage means (14). Thereby, a temperature control with a high precision becomes possible.

[Translation done.]

* NOTICES *

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- 3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the block diagram showing the example of this invention.

[Drawing 2] It is the timing chart of an example.

[Drawing 3] The lock-up time of the control circuit of an example is drawing showing early operation.

[Drawing 4] It is drawing showing operation which serves as power saving in the noise of the control circuit of an example strongly.

[Drawing 5] It is the block diagram showing the composition of the PLL synthesizer which has the conventional charge pump.

[Drawing 6] It is drawing showing the composition of the conventional charge pump.

[Drawing 7] It is the conventional timing chart.

[Drawing 8] It is the block diagram which took the measures which bring the conventional lock-up time forward.

[Description of Notations]

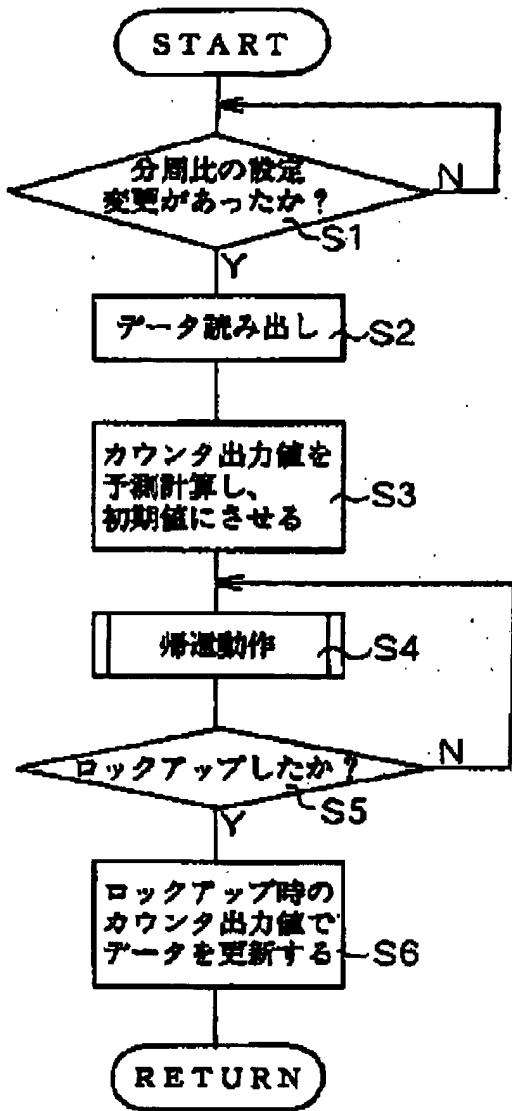
- 1 Voltage Controlled Oscillator
- 2 Programmable Divider
- 3 Temperature Compensated Crystal Oscillator
- 4 Counting-down Circuit
- 5 Phase Comparator
- 6 Charge Pump
- 7 Phase Comparator
- 8 Clock Pulse
- 9 Updown Counter
- 10 Latch
- 11 Digital Signal Converter
- 12 Low-pass Filter
- 13 Control Circuit
- 14 Storage Means

[Translation done.]

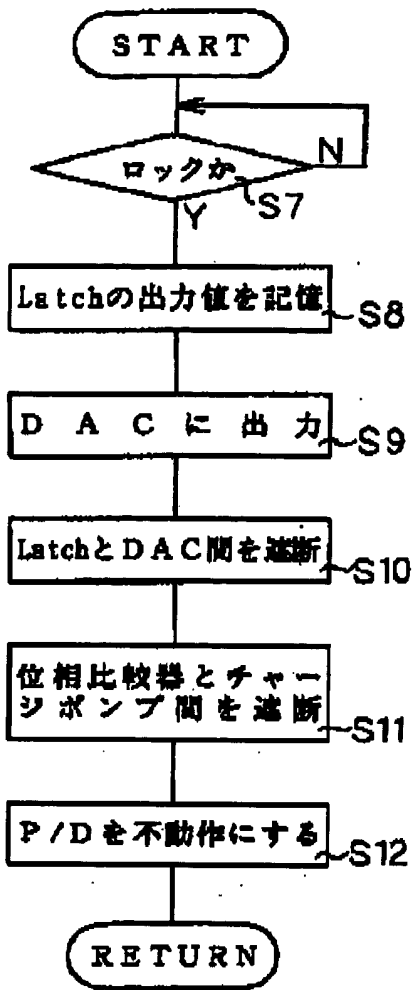
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[Drawing 1]

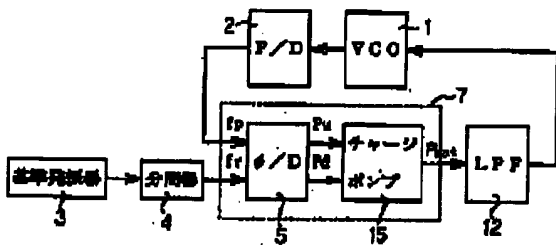




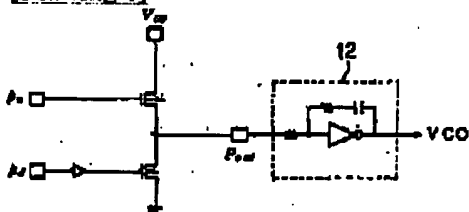
[Drawing 4]



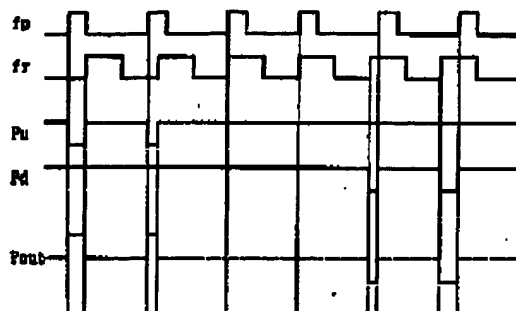
[Drawing 5]



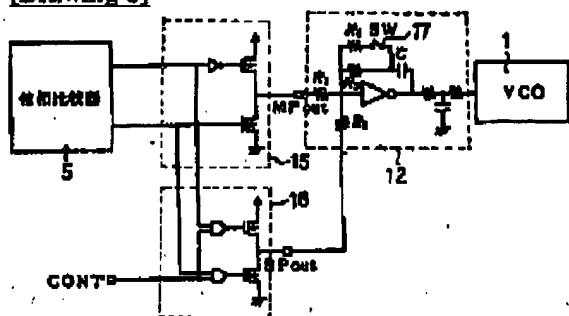
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]